Cogeneration's Rewards and Challenges:

The University of Calgary Experience

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Cogeneration's Rewards and Challenges:
The University of Calgary Experience

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Agenda

1. Project "Drivers"
2. Project Implementation
3. Results & Performance
4. Challenges & Solutions
5. Observations & Advice

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1 Project "Drivers"

- ✓ MUST do 'something'!
- ✓ Alberta Spark Spread

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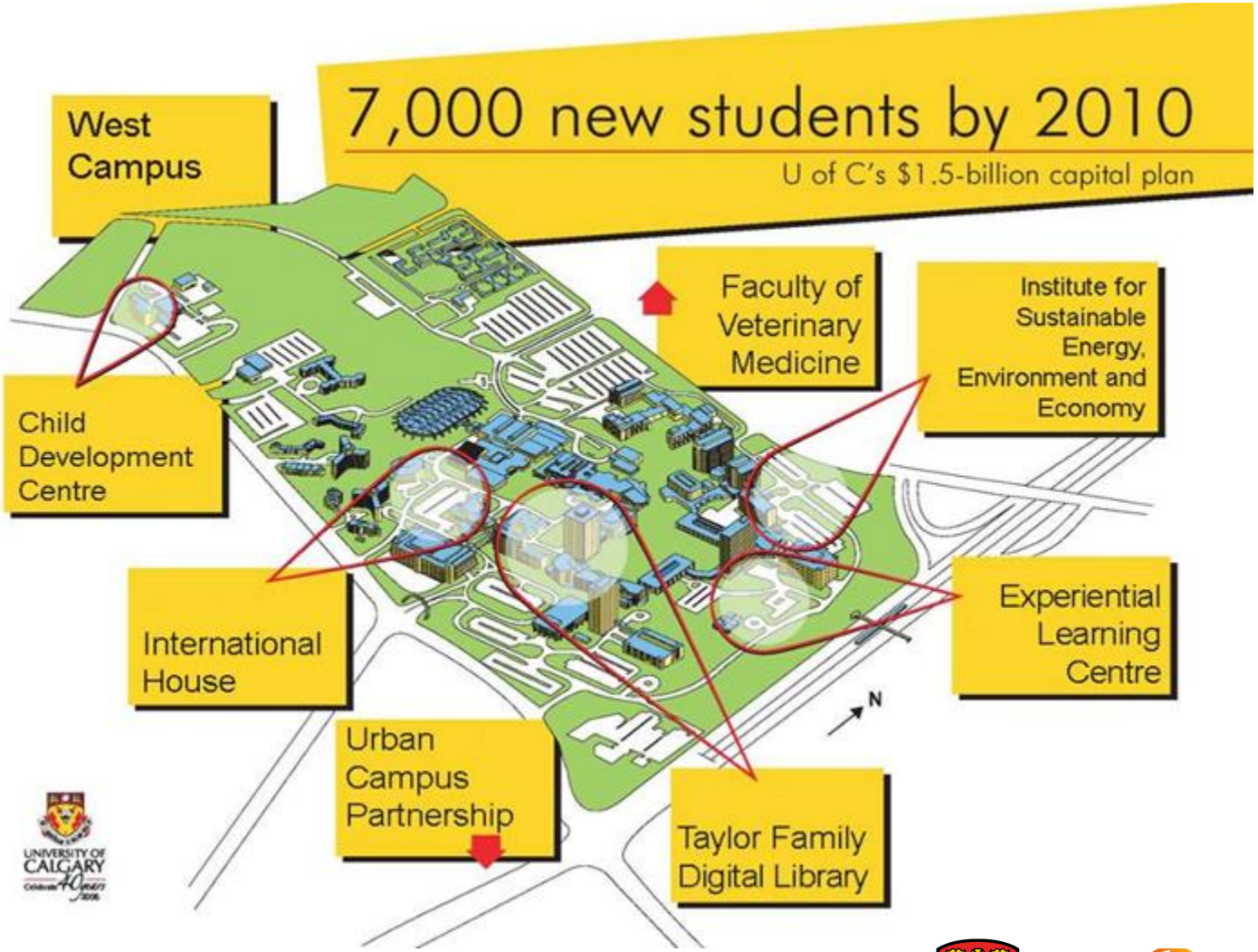
Project Main Driver:

2006 Campus Expansion Plan ($1.5 billion)



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Campus Today

- 30,000 Students
- 5,000 Staff & Faculty
- 10 million SF buildings
- 24 MW electrical peak
- 200 MMBTU/hr. heating peak
- 8,500 tons cooling peak

Grid Power vs Natural Gas

	2007	2015	2022
GAS			
Commodity Charges	$ 8.00	$ 3.50	$ 6.00
Delivery Charges	$ 2.00	$ 2.00	$ 2.00
$/GJ >	**$ 10.00**	**$ 5.50**	**$ 8.00**
POWER			
Commodity Charges	$ 70.00	$ 45.00	$ 80.00
Delivery Charges	$ 20.00	$ 25.00	$ 45.00
$/MWh >	**$ 90**	**$ 70**	**$ 125**
"Break Even" ($/MWh)			
Cogeneration	**$ 72**	**$ 54**	**$ 64**
Simple Cycle	$ 120	$ 76	$ 101

@ 2,500 $/kW

@ 1,500 $/kW

@ 4% interest, 20 yrs

$1,640,000

Net Annual Savings 2015 - (13 MW CHP @ 90% capacity factor)

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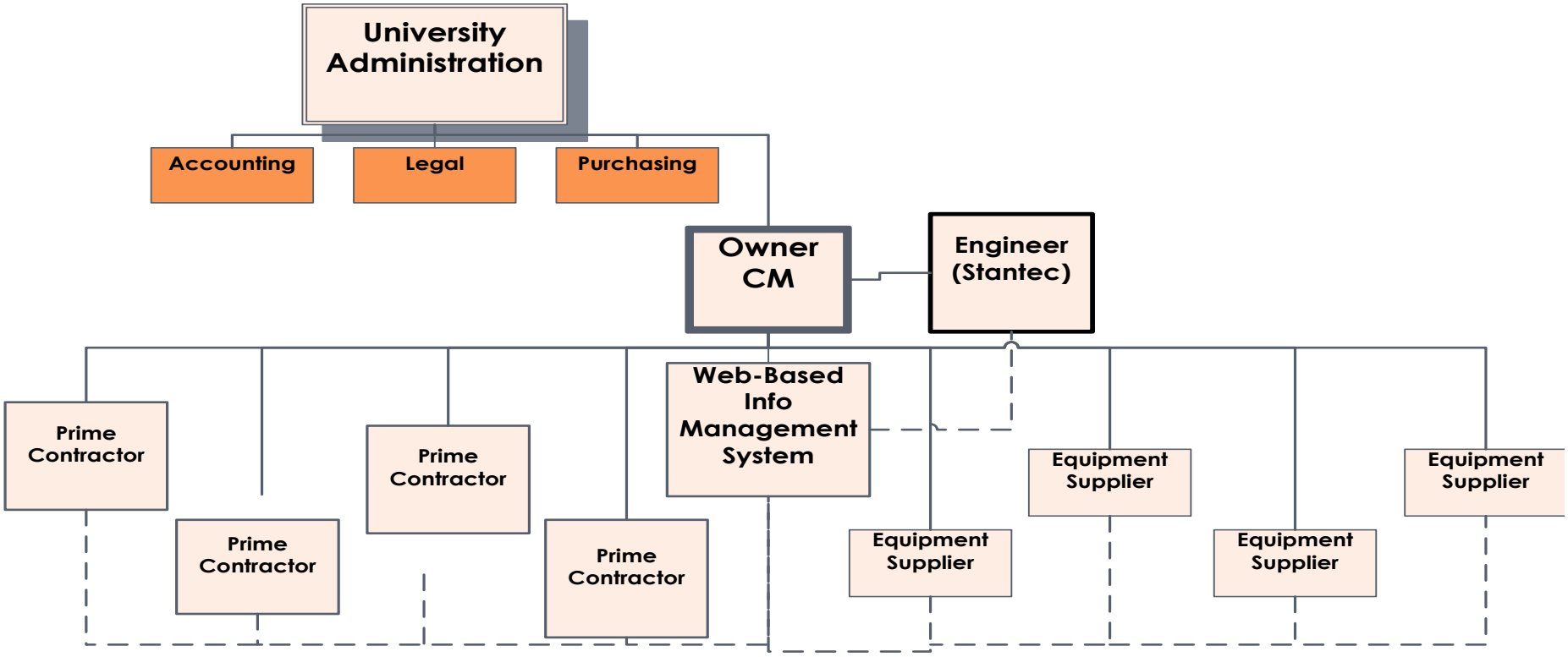
2 Project Implementation

Owner as Construction Manager

Owner as Construction Manager



- ✓ Substantial Completion **On Schedule**
  (commercial operation delayed 6 months)
- ✓ Project Cost **Under Budget** (Scope was Expanded to Budget Limit)
- ✓ **No Major Disputes** (all were settled in the course of the work)
- ✓ University **happy with Results**

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3 Results and Performance

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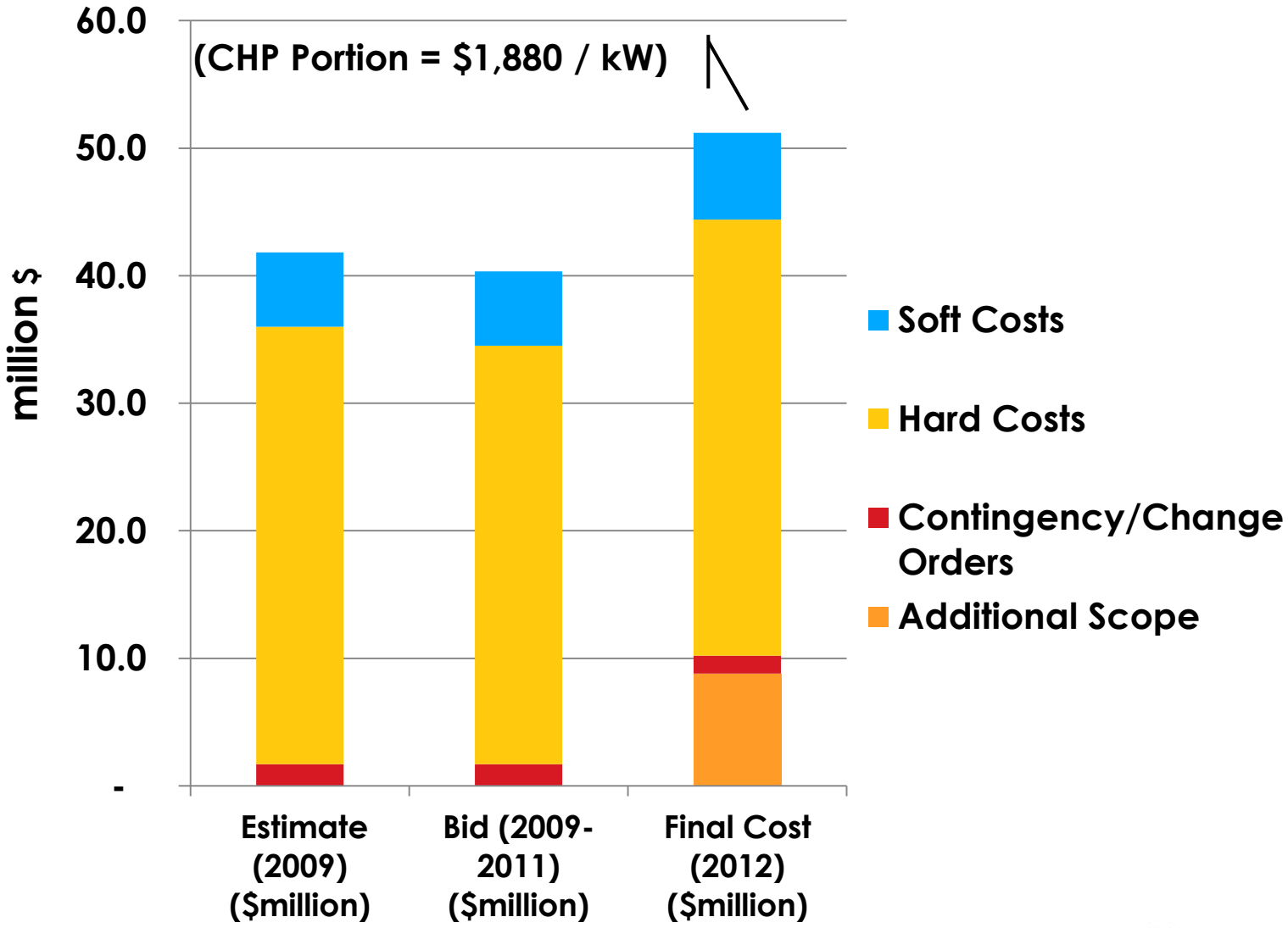
Results – Project Cost



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Results - Financial Performance

- ✓**3 – year avg. Capacity Factor: 75%**
  (Target Capacity Factor: 90%)
- ✓**3 – year Operating Savings: $12.3 million**
- ✓**3 – year Net Savings (Profit): $5.0 million**
- ✓**CHP System Cost: $25.0 million**
  (Total Project Cost: $50.0 million)

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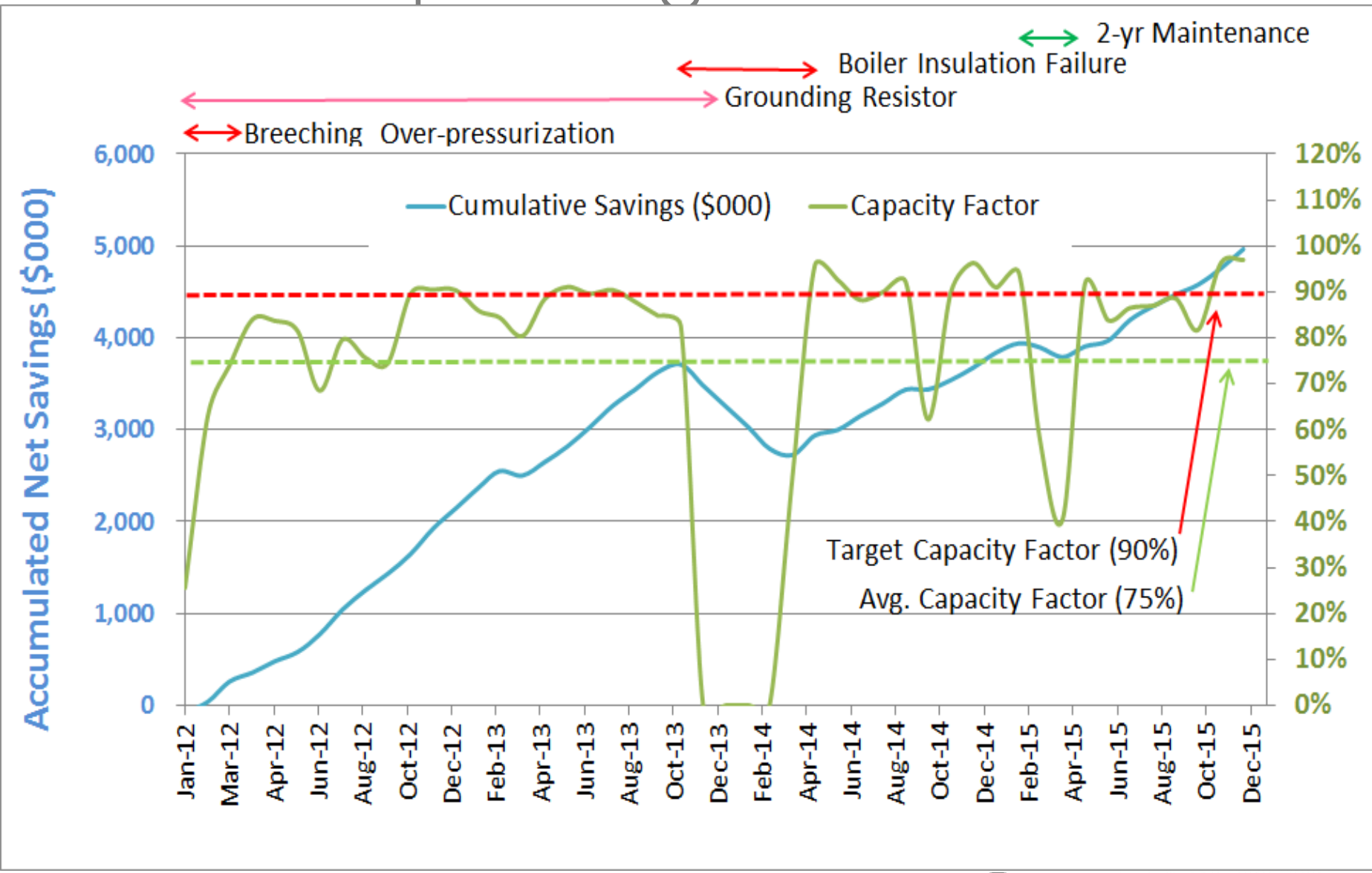
Results - Operating Performance



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4 Challenges and Solutions

- High Neutral Currents (Harmonics)
- Breeching Bypass Failure
- Boiler Tube Failure
- Boiler Insulation Failures
- Control issues, doing it right the first time

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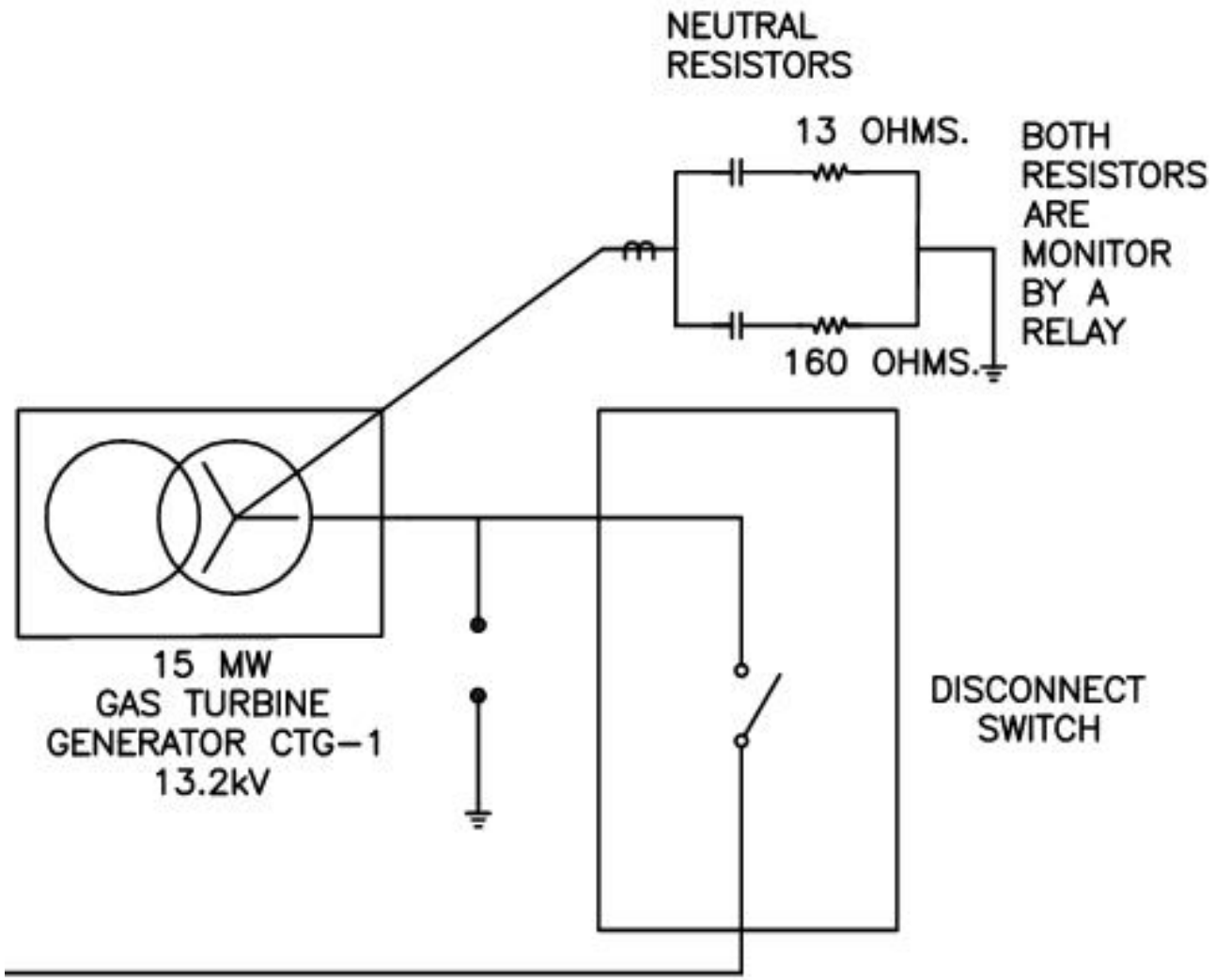
High Neutral Current – (Harmonics)



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Breeching Bypass Failure – Post View

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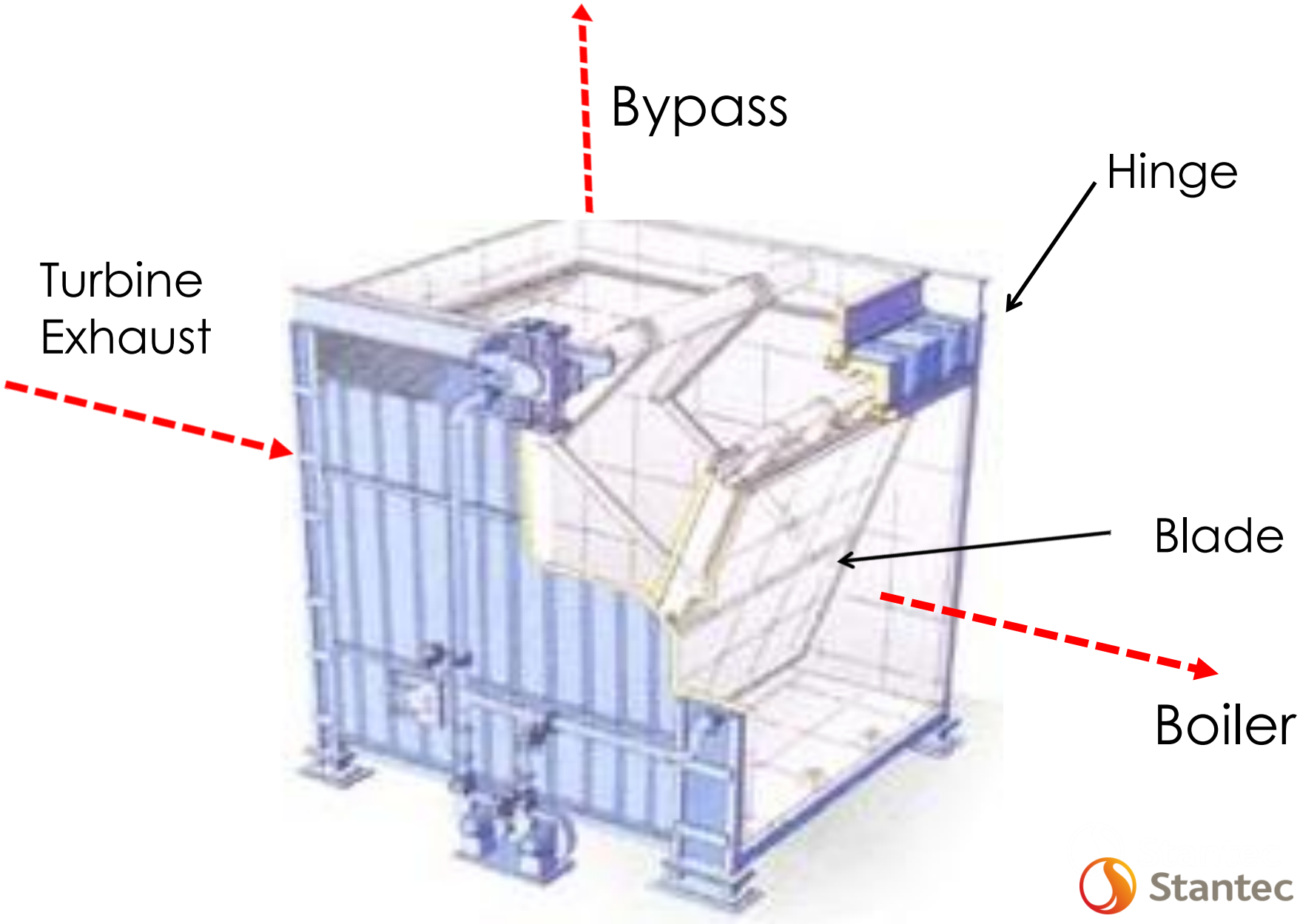
Bypass Failure – What Caused it?



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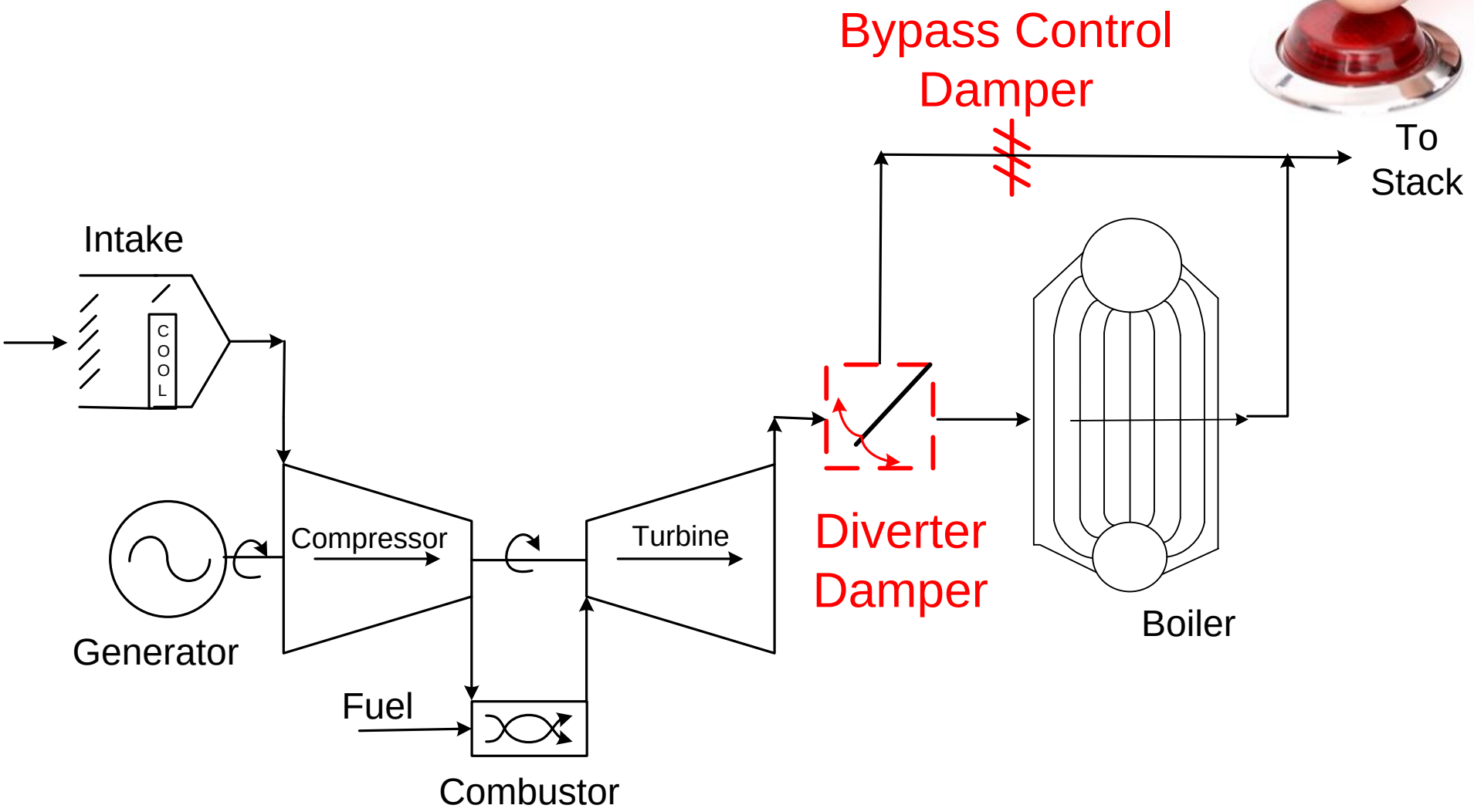
Bypass Failure – What Caused it?



Boiler Tube Failure

1 year after start-up – warped baffle hitting tube

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Boiler Tube Failure

Repair appeared straightforward (at first)

- Grooves were cut in tube by U-bolts holding the acoustic baffle.
- The entire bottom tube of the header was removed and re-installed.
- Baffle supported by new angle, but U-Bolts hold the baffle further up the tube bank.

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Boiler Insulation Failure - (2 years in)

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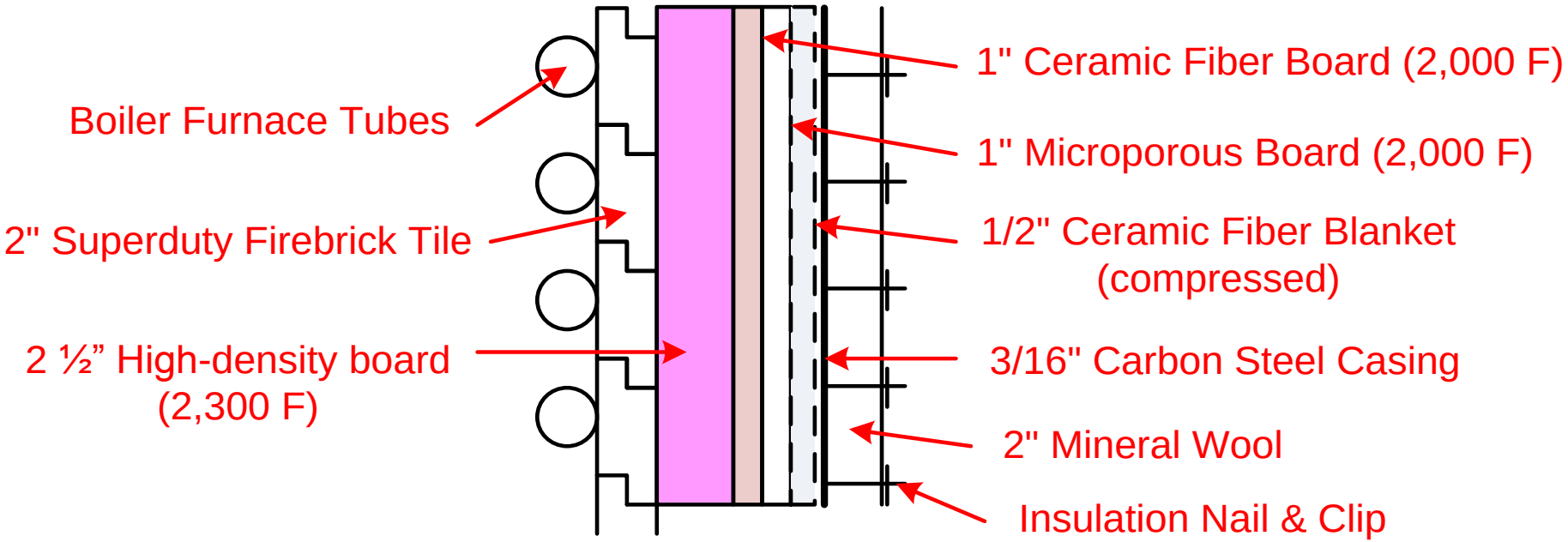
Boiler Insulation Failure

Insulation board exposed to turbine exhaust could not withstand the hot gas erosion.

The 'fix'



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Controls Issues

- ✓ **Control programming and making everything TALK to each other:** can become a daunting task, especially in the late stages.
- ✓ **The Right Steps Early in the design phase** can have profound cost savings later on in the 11th hour of project completion.

You dictate the Control Providers' options:

1. **I have all the logic diagrams** I just need you to program it and make it work.

2. **I have some logic diagrams**, details about the operations and know how everything is supposed to work.

3. **I got some narratives on how it should work, but we need help.**

4. **I don't have a clue** how this is going to work…. **HELP.**

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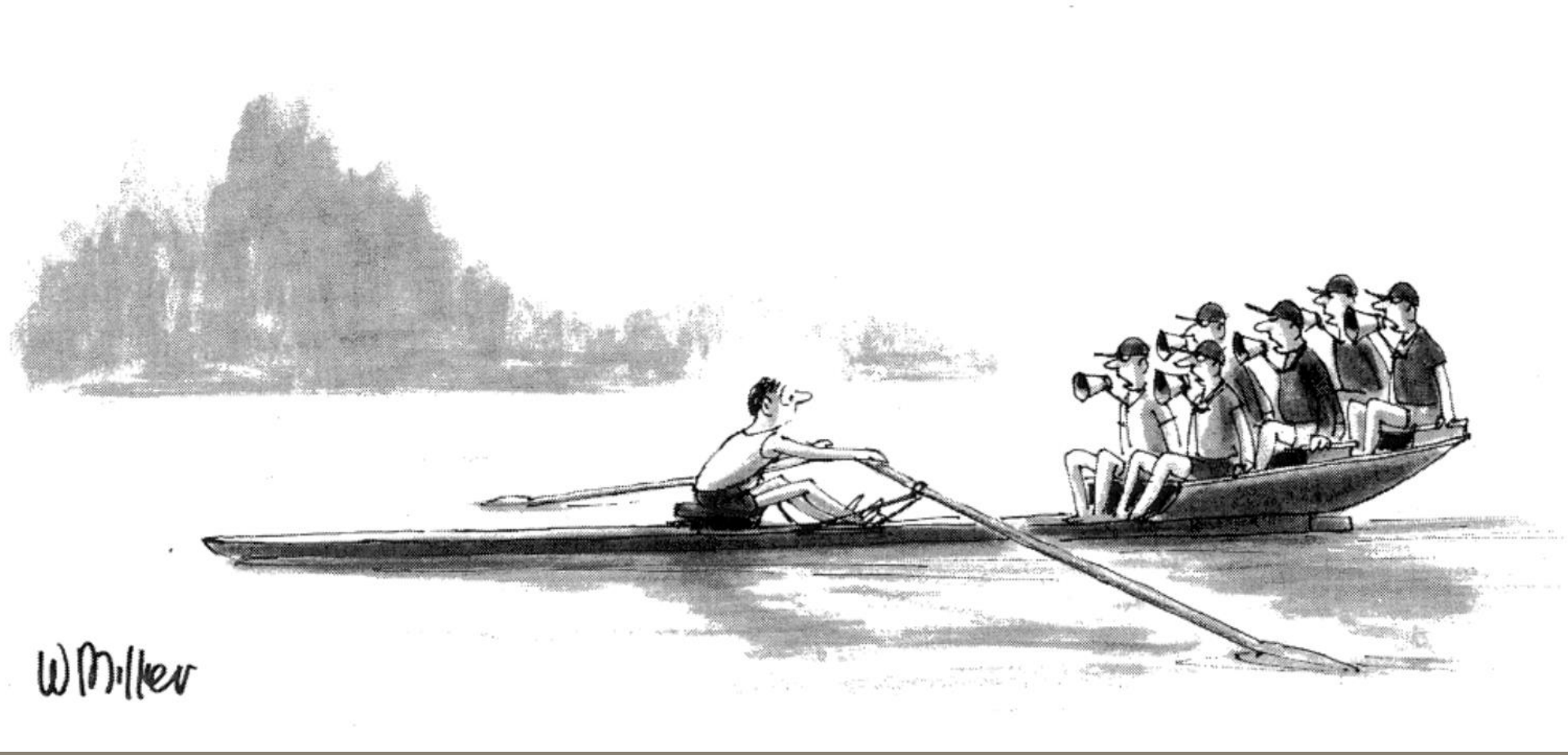
5 Observations and Advice



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Observations & Advice

1) **<u>"Owner as Construction Manager" has advantages and drawbacks:</u>**

+	Cost & Schedule Control
+	Cost savings
+	Shorter Operator Learning Curve
+/-	More Risk (and Reward)
-	Full-Time, Skilled Owner PM Essential
-	Good Information Flow & Management Essential

<u>BOTTOM LINE</u>: **Recommend it!**

2) **<u>Electrical "Harmonics"</u>**

<u>BOTTOM LINE</u>: **Higher Cost of Isolation Transformer (probably) Worth It**

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Observations & Advice

3) Control System Design

BOTTOM LINE:
Spend Time/Money in Design to "Work Out the Details"

4) Start-up and Commissioning

BOTTOM LINE: **Provide Enough Time**

5) "Bugs"

BOTTOM LINE: **Deal with it CONSTRUCTIVELY**

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Questions?

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